DYNAMIC WAREHOUSING STRATEGIES

On-demand warehousing for ecommerce

Karl Siebrecht
CEO, FLEXE. karl@flexe.com

Amitabh Sinha
Associate Professor, Ross School of Business, University of Michigan.
amitabh@umich.edu

Stephen Johanson
President, Starboard Solutions Corp. steve@starboardcorp.com

Vivek Rajeevan
Student Consultant, MBA Class of 2017, Ross School of Business, University of Michigan. vivekraj@umich.edu

Tauber Institute White Paper, May 2016.

A webinar hosted by JOC accompanying this white paper is available on-demand at www.joc.com/webcasts.

Executive Summary

Dynamic warehousing is a warehousing strategy consisting of purchasing warehousing services in a pay-per-use model, on an electronic marketplace.[1] This can be the entire warehousing strategy for a company, or it may be an activity that supplements an existing network built on long-term contracts. In either case, it allows the retailer to quickly adapt to variable demand and cost conditions.

Retailers only pay per-unit costs for the services they use, thus avoiding capital expense: this is particularly useful in ecommerce, where retailers typically face high demand uncertainty while also being capital-constrained. Additionally, dynamic warehousing allows ecommerce retailers to rent small units of capacity in many parts of the country, enabling quick delivery to a large fraction of customers.

This white paper introduces the concept of dynamic warehousing, and demonstrates its value via a case study.

Warehousing today

Warehousing is integral in retail operations, serving to distribute goods efficiently to the locations where demand exists. Before the advent of ecommerce, many retailers used warehouses as intermediate storage points (distribution centers or DCs) to supply their retail stores. In this traditional or brick-and-mortar retail model, actual consumer demand is fulfilled from retail stores. Therefore, a retailer could implement a DC network consisting of a small number of DCs, each serving a "region" comprising many states, with replenishment lead times of a few days.

According to CSCMP's Annual State of Logistics Report[2], total logistics expense in the US in 2014 was $1.45 trillion, equating to approximately 8.3% of GDP. Of this, $900 billion was transportation costs. Although warehousing alone accounts for only 10% of total logistics cost at $143 million, warehousing has a significant effect on transportation costs: a more extensive network reduces outbound shipping costs (which is generally more expensive per unit), despite some increase in inbound transportation costs.

[1] This is also called on-demand warehousing, although in this report we will exclusively use the term "dynamic warehousing".

[2] CSCMP's Annual State of Logistics Report, Council of Supply Chain Management Professionals, Lombard, IL. 2015.

Ecommerce and its impact on warehousing

With the advent of ecommerce, however, it is becoming apparent that the traditional warehousing model is insufficient to deal with market realities. Ecommerce is growing very fast within retail: total US ecommerce sales in 2015 clocked in at $340 billion, comprising 7.5% of total retail, and growing at a 14.7% annual rate[3].

Ecommerce creates significant challenges in terms of customer expectations, compared to traditional retail. Much of this is due to Amazon.com, which is the market leader in ecommerce: by building an extensive distribution network along with delivering excellent customer service, it has set up expectations in ecommerce that apply to all retailers.

Traditional retail (pre-internet)	Ecommerce
Outbound shipping is in larger quantities to retail stores.	Outbound shipping is in extremely small quantities to individual customers.
Outbound shipping time can be a few days, because it is only replenishing store inventory.	Outbound shipping time is critical, with many customers expecting items within 2 days or less.
Demand variability is usually small, influenced only by mass media with slower news cycles.	Demand can be highly variable, influenced by social media and faster news cycles in internet media.

Ecommerce is changing the nature of the warehousing industry as well. Ecommerce retailers keep more inventory in warehouses, because of the lack of retail stores. As a result, demand for warehousing space is growing, as is the need for an efficient warehousing and distribution strategy. To quote the CSCMP Annual State of Logistics Report:

"Growing inventory levels filled all available capacity, with the national vacancy rate dropping 2.7% to 7%. Same-day delivery models and expanding e-commerce are reshaping warehousing needs and expanding the penetration of warehouse management software to handle some or many tasks that are well beyond the traditional warehouse offerings of the past. New operating strategies and warehouse location requirements are changing the face of this sector."

In this white paper, we will explore one such "new operating strategy" and its associated "warehouse location requirements": the idea of dynamic warehousing.

Need for alternative warehousing solutions

Most retailers have relatively small ecommerce volumes. The focus of this white paper is on new or emerging ecommerce retailers, where volumes are even more likely to be very small.

[3] Quarterly Retail E-commerce Sales, 4th Quarter 2015, US Department of Commerce.

With small volumes, dealing with the challenges of ecommerce distribution listed above is extremely difficult. Before dynamic warehousing, the following were the options faced by such a retailer:

- Startup – Drop ship: If the retailer owns its own manufacturing/assembly facility, initially it may ship directly from that facility. Many small ecommerce retailers start this way.
- Self-owned network: If the retailer operates its own network of warehouses, it is unlikely to have the scale and financial resources to build a very extensive network. As a result, the average distance to the customer is high, resulting in high shipping costs and longer delivery times.
- Network outsourced to 3PL: Although this offers a little more flexibility compared to a self-owned network, most 3PLs demand commitments of 1-3 years. This effectively locks in the retailer into a fixed structure for a period of a few years.
- Distribution outsourced completely: Amazon, for instance, offers a service called "Fulfillment by Amazon" (FBA), wherein Amazon distributes the retailer's products through its network. Although this can provide excellent service times to customers, the costs can be high and many retailers are wary of handing over a core part of the business to their main competitor.

Dynamic warehousing: what is it?

The main idea behind dynamic warehousing is that the shipper has access to a large network of warehouses, and can activate warehousing services from bulk pallet handling to fulfillment in small to large volumes and for relatively short amounts of time "on the fly". For example, a small ecommerce retailer may decide to create half-a-dozen different distribution points, for as little as 50 pallets at each warehouse, with little to no fixed time commitment. The warehouse provider would use its own labor and equipment to perform standard and optional services such as receiving, shipping, case pick, item pick, packing, etc., and would charge the retailer on a per-unit basis.

Dynamic warehousing is "dynamic" in the sense that the retailer can change the configuration frequently: based on demand conditions, warehouse space could be deployed at different locations, for different volumes, in a dynamic fashion.

In such a system, the retailer incurs no upfront fixed costs, and gains significant flexibility. Of course, the unit cost charged by the warehouse provider may be higher or lower than what would be incurred by the retailer if it operated its own high-volume high-utilization warehouse. But this is the benefit of dynamic warehousing: the retailer gains flexibility and avoids capital expense, even if sometimes the per-unit cost is higher.

To make this happen, one needs a two-sided marketplace where warehouse providers can list their space, and retailers find space. Additionally, because of the significant role of technology in managing inventory, inbound and outbound shipments, and orders in ecommerce, the marketplace would need to offer an Order Management System and an integrated Warehouse Management System, that can link the retailer's systems with the warehouse providers'. Flexe.com[4] is one such company operating in the United States that provides this service.

Compared to a traditional third party logistics provider, dynamic warehousing offers the ability to rent significantly smaller spaces for significantly smaller amounts of time. This is analogous to what is already common in many other industries: for example, in trucking, a retailer can (i) operate its own fleet of vehicles; (ii) enter into long-term contracts with large trucking companies, or (iii) move loads by contracting with one truck at a time through a freight exchange. Moving from (i) to (iii), we see the capital expense decreasing, unit costs increasing, and flexibility increasing: these are the same tradeoffs in warehousing as one moves from operating one's own network, to contracting with 3PLs, to dynamic warehousing.

Given these tradeoffs, it should be clear that dynamic warehousing is not beneficial for everyone. If a retailer already has large volumes with fairly predictable demand (e.g. Walmart), then operating its own network will be the most cost-efficient. Dynamic warehousing is best suited for retailers facing small but highly variable demand, such as emerging ecommerce retailers. For other mid-size retailers, dynamic warehousing can play a role as a "filler" to handle unexpected demand variability, complementing a primarily self-operated and 3PL-based network.

Value for warehouse operators

Dynamic warehousing provides a positive value proposition for warehouse owners as well. Building a warehouse can be expensive; any unused space has an opportunity cost. Even if a warehouse owner/operator has long term contracts with retailers or 3PLs for much of its space, any remaining space can be turned into a revenue-generating asset by placing it on a dynamic warehousing marketplace. Depending on the warehouse owner's operating costs, opportunity costs, and market dynamics, it can choose a price that may be more, or less, than the rates it charges its existing clients.

[4] www.flexe.com

Case study: Expanding ecommerce retailer facing variable demand

To illustrate the economics of dynamic warehousing and compare it to a traditional operation, we consider a simple case study of an ecommerce retailer with a single plant in Ontario, California (equivalently, the retailer imports all its goods into the port of Los Angeles). We will then see how the retailer can use dynamic warehousing to expand its network. Some basic characteristics of the retailer and its demand are as follows:

Utilization Level	95%
Total Annual order quantity	1 M
SKU count	500
Units per order	1.5
Plant location	Ontario, California
Area	95,000 sq.ft.
Customer Demand Map	Mirrors US population

Table 1: Basic characteristics of case study: base case

Test Case 1: One warehouse serving all customers in US

In its initial network, the retailer simply uses small package shipping to ship orders to its customers, who are spread across the US. Using demand information, standard industry transportation costs, and a fixed warehouse location near the plant, we can calculate the cost of operating the network. For this, and all the network design in our study, we use Tactician, a web-based network optimization software[5]. The optimal network and resulting operating costs are shown in **Error! Reference source not found.**.[6]

Of the total cost of $2.25 M, about 80% is outbound transportation, from the warehouse to the end customer. Inbound transportation rates are very low, but the distance is minimal. So, in order to reduce transportation costs and in turn total costs and improve service level, it would make sense to have multiple warehouses across the country. However, this also implies higher warehousing costs as the fixed costs would increase as we add more warehouses to the network.

Total Cost per order	$ 11.89
Transportation cost per order	$ 9.53
Order fulfilment within 2 days	12%
Total committed cost	$ 2.25 M

[5] Tactician is developed by Starboard Solutions Corp., and is available at www.starboardcorp.com.

[6] Only high-level calculations are reported in this white paper. Complete details of calculations are available upon request.

One Time Fixed cost	$ 225 K
Three year locked in lease	$ 2 M
Total annual cost	$ 11.9 M

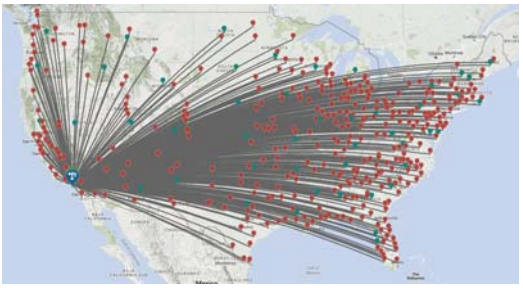


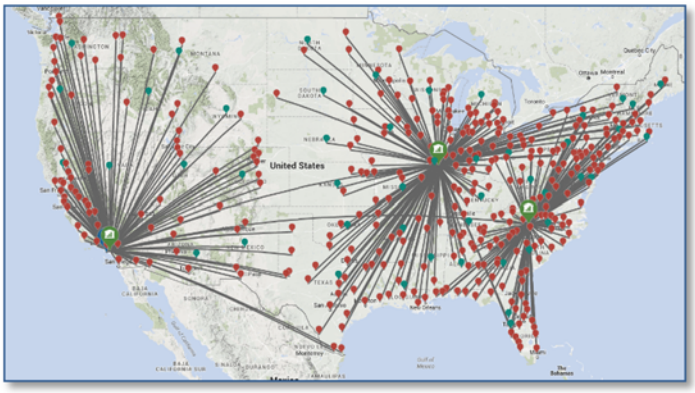
Figure 1: Network structure and operating characteristics for base case.

Also note that the existing network only delivers 12% of orders within 2 days. As the ecommerce industry moves towards faster and faster delivery times (same-day is increasingly common), it is important for the ecommerce company that the customer service level is as high as possible while maintaining reasonable costs.

Test case 2: 70% & 90% orders fulfilled within two days

We now consider the case where the goal is to deliver 70% of the orders within 2 days, at minimal cost. Again using our demand and shipping information as described above, as well as industry standard warehouse costs, we use Tactician to find the optimal network. The optimal network has 3 warehouses, in CA, IL, and NC.

	Size (sqft)	Utilization	Startup Costs	Annualized Lease Cost
Fullerton, CA	22,000	95%	$110k	$158k
Decatur, IL	38,000	95%	$130k	$275k
Statesville, NC	34,000	95%	$125k	$244k



Total Cost per order	$ 10.25
Transportation cost per order	$ 7.76
Warehousing cost per order	$ 2.49
Total annual cost	$ 10.25 M

Figure 2: Network structure and operating costs to guarantee 70% delivery within 2 days.

Similarly, if we want 90% deliveries within two days we would require a total of 8 warehouses. The network would look as below:

Total Cost per order	$ 10.44
Transportation cost per order	$ 7.48
Warehousing cost per order	$ 2.96
Total annual cost	$ 10.44 M

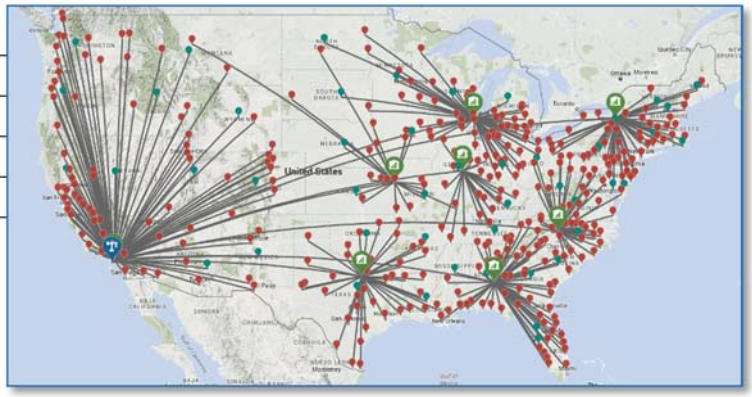


Figure 3: Network structure and operating costs to guarantee 90% service within 2 days.

This network has 8 warehouses[7], reflecting the need to get closer to the customer. Many ecommerce retailers are also offering same-day shipping capability; to be able to serve 90% of customers within 1 day, we would need a network of 16 or so warehouses.

For a small ecommerce retailer, the capital expense required to build out such a network would be prohibitive. Locking into long-term leases with 3PLs may also be risky, especially if volumes are insufficient to gain economies of scale. This brings us to dynamic warehousing: suppose the retailer was able to rent space, using current marketplace rates, for the same network?

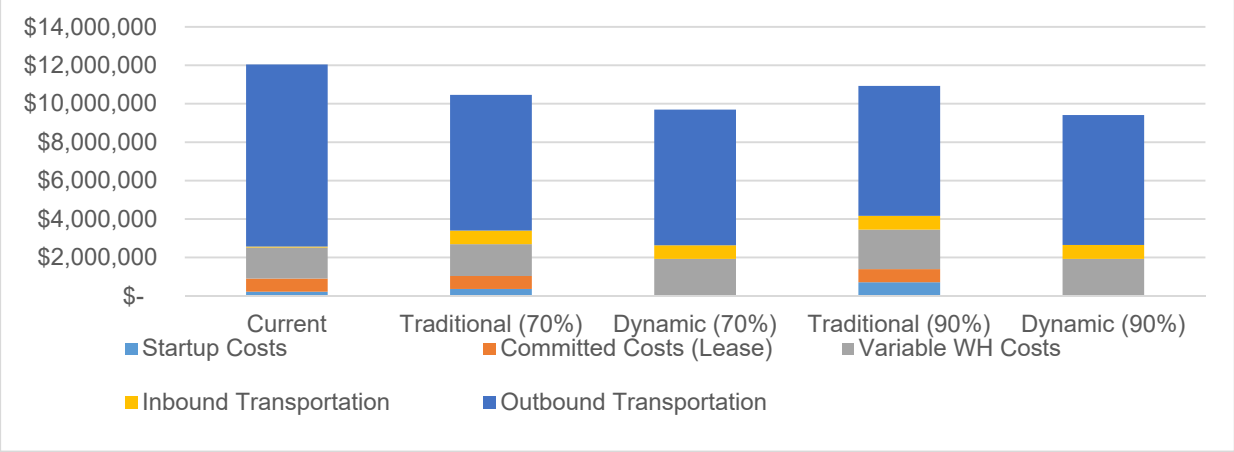


Figure 4: Comparative costs of network models with and without dynamic warehousing.

Figure 4 displays the costs of the three networks examined above, as well as the latter two networks operated using dynamic warehousing. For dynamic warehousing, the network structure is the same (i.e., warehouses are located in the same places as the corresponding traditional network). However, there are no start-up costs; instead, the dynamic network uses

[7] Coincidentally, Walmart is also targeting free two-day shipping using a network of 8 DCs, supplemented by its retail stores. See http://fortune.com/2016/05/12/walmart-shipping/.

marketplace costs for warehouse space which are only slightly higher per-unit than in a traditional network.

Of course, the relative advantage of the dynamic network depends on many factors: the actual marketplace rates for warehouse space, demand variability, etc. Note that marketplace rates for warehouse space may be *greater than, or less than*, standard rates with a 3PL. If the warehouse provider has surplus space that will be otherwise unused, it may well offer below-market rates in the short term. On the other hand, in a high-demand location, marketplace rates are indeed likely to be higher than 3PL rates. We address the demand variability and its impact on dynamic warehousing next.

Test Case 3: Growth scenarios

Let us now assess the value proposition of dynamic warehousing model in an uncertain environment. We consider three growth scenarios: annual growth rates of 10%, 20%, and 30% respectively. The resulting annual volumes are shown in Table 2.

		Annual Order Volume (Forecast)		
Annual Growth (Forecast)	Growth rate (%)	Year 1	Year 2	Year 3
Base	20%	1,056,000	1,267,200	1,520,640
Low	10%	1,056,000	1,161,600	1,277,760
High	30%	1,056,000	1,372,800	1,784,640

Table 2: Order Volumes under different growth scenarios.

To model the traditional system, we assume that the retailer is locking in capacity for 3 years with sufficient capacity to meet peak demand. This means that the retailer would lock in sufficient space to meet annual demand of 1,784,640, even though in year 1 utilization would be much lower than that. This is conservative; the retailer may well be able to negotiate capacity reservation with the 3PL that does not require so much unused space in Year 1. Nevertheless, for our calculations, we assume that the full capacity is reserved up front.

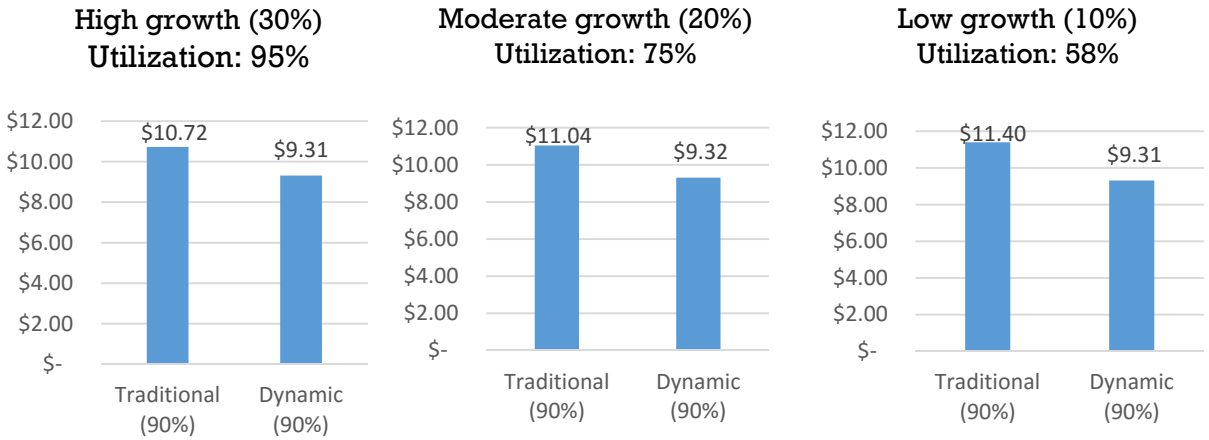


Figure 5: Cost per order with variable demand growth.

Figure 5 shows the cost per order incurred as the actual growth rate varies, assuming the firm installed capacity for the high growth scenario. In the leftmost graph, actual growth was indeed the 30% that was expected, leading to cost per order of $10.72 and $9.31 for the traditional and dynamic networks respectively. The next two graphs show the costs if the actual growth rate was moderate (20%) and low (10%) respectively. In those cases, the cost per order with a traditional network rise to $11.04 and $11.40 respectively, because utilization decreases. Cost per order under the dynamic model, however, stays unchanged at $9.31 because of the pay-per-use nature of the dynamic warehousing system.

Of course, the retailer may choose to invest assuming a low growth scenario, and not risk low utilization. In that case, the opposite problem will arise: if actual growth is high, then the retailer runs out of capacity, and risks either losing demand or having to pay other costs to meet the unexpectedly high demand.

This ability to deal with uncertainty is one of the key benefits of dynamic warehousing. Uncertainty and variability arise in many forms, as we will discuss shortly. It should also be pointed out that a retailer may deploy a strategy that mixes traditional warehousing with dynamic warehousing: operate some warehouses which it owns or contracts with 3PLs, and use dynamic warehousing as a filler when needed. That may indeed provide an even better level of costs and service levels.

Other pros and cons of dynamic warehousing

Dynamic warehousing offers the ability to hedge against other types of variability, in addition to the volume variability analyzed in this white paper. For instance:

- ***Regional variability***: Demand could grow much faster in some regions than in others. Dynamic warehousing provides the ability to increase warehousing capacity in regions with high/fast-growing demand, and decrease warehousing capacity in regions with declining demand.

- ***Cost variability***: Operating costs could change in different ways across different regions. For instance, tax policies in one state could make costs particularly attractive there, while wage and rent inflation could make other regions unattractive. A dynamic warehousing network can quickly adapt to such changes.

- ***Supplier variability***: As the ecommerce retailer grows, it may add new suppliers in other parts of the country. Or, the supplier itself may add new facilities, or transportation disruptions may make the flow of imports arrive through a different port. Again, dynamic warehousing can quickly adapt to these changing conditions.

It should be mentioned that dynamic warehousing is not without its own risks. The single biggest risk is that the retailer is exposed to market rates for warehousing space. That is, much like Uber's surge pricing, market conditions may cause warehousing rates to spike suddenly. A retailer who has its own network of owned/operated warehouses will typically be in a better position to manage its costs, while a retailer exposed to the market for warehousing services via dynamic warehousing is exposed to this risk.

Another potential risk factor arises from the fact that orders are being fulfilled by a network of unrelated warehouses contracted only through an electronic marketplace. As in any such outsourcing situation, the retailer is subject to the risk that operating conditions at some warehouses may not be optimal, leading to, for example, errors in order fulfillment or misalignment with the retailers values and objectives. This risk can be mitigated by appropriate contract structures and monitoring, both on the marketplace platform and via third parties.

We also note that dynamic warehousing does not present an either-or decision with respect to traditional warehousing. A firm may well find it even more advantageous to operate a hybrid network, with some fraction of inventory and orders going through its self owned/operated network and the remainder through a dynamic warehousing network. Such a system can offer most of the advantages listed above while also lowering the risk exposure; however, it would require some amount of capital expense.

Conclusion

Over the last few years, information and communication technologies have led to the emergence of electronic marketplaces for a number of services and business activities. The most famous of these is of course Uber, but these marketplaces exist for everything from simple human tasks to outsourced manufacturing abroad. This phenomenon is perhaps most accurately called "platform capitalism",[8] and the most significant enabler of it has been the rise of cheap and high capacity information and communication technologies. Recent trends suggest that platform capitalism is only going to grow, in both B2B and B2C settings, as companies focus on their core competencies and take advantage of the flexibility and cost benefits that come with a well-functioning marketplace with multiple suppliers of all the services a business needs to operate.[9]

Dynamic warehousing can therefore be seen as an instantiation of platform capitalism in the warehousing services industry. As overall warehousing costs continue to rise, and rise at

[8] See, for example, https://www.theguardian.com/technology/2015/jun/07/facebook-uber-amazon-platform-economy and http://networkcultures.org/mycreativity/2014/10/16/never-mind-the-sharing-economy-heres-platform-capitalism/.

[9] The Vanishing American Corporation by Gerald Davis is a recent book that strongly makes this case.

dramatically different rates in different parts of the country,[10] dynamic warehousing offers emerging retailers the flexibility to compete in such an environment. Of course, reserving and operating warehousing services is more complicated than hailing a ride on Uber, but that is where software systems and technology can provide efficient solutions.

In summary, there is a strong case that not only does dynamic warehousing offer a cost-efficient way for small ecommerce retailers to offer high service levels in a flexible fashion, but in fact it is likely to become a standard way of contracting for warehousing.

Acknowledgements

This white paper was supported by Flexe.com. Ishan Khandelwal's initial research assistance is gratefully acknowledged.

[10] As reported in the Wall Street Journal on May 16, 2016, ecommerce has driven warehousing rates overall to rise 9.9% in one year, with the San Francisco bay area seeing a 28.9% increase. See http://www.wsj.com/articles/e-commerce-drives-surge-in-u-s-warehouse-rental-prices-1463391930